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MEMORANDUM FOR THE FILE

16 September 1957

FROM: [REDACTED]

SUBJECT: Thermocouples and Meters in the TAC-1 Antenna Tuner

REFERENCE: SEB 7-138

With regard to the referenced memorandum, the investigation of the cause (s) of burned out thermocouples and meters was picked up as a project. The following report contains the suspected causes(s) of this trouble and the results of the investigation.

About 15 August Messrs. [REDACTED] visited the local [REDACTED] representative. The reason for this visit was to get their comments on a burned-out thermocouple we had with us and to find out if they had experienced any similar troubles on these parts. Their answer was negative; they have had no trouble with either the thermocouples or meters. These parts, they stated, are being used in many applications and without complaints of any sort. We left the damaged thermocouple with them for factory inspection and repair.

On 1 August four new thermocouples and two meters were requisitioned from stock to be used in the following test:

- a) Determine if the thermocouples are wired correctly.
- b) Check on the accuracy of the meters and thermocouples.
- c) Check on the resonant or parasitic circuits in the TAC-1 meter circuit.
- d) Check on possible PF rectification in the meter circuit.
- e) Test the sample meters and thermocouples in the TAC-1 for proper or improper operation if possible.

This investigation took place at the T&I Section, [REDACTED] and the results of the above test were indicative of good quality meters and thermocouples, correctly wired in the circuits. There was no indication of parasitics or faulty design of the TAC-1. Since the referenced memorandum suggests many possible solutions to the problem, each will be used as a guide to expand the following points:

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Thermocouples Wired Incorrectly

The connections to the thermocouple were changed to provide all possible combinations. Only one way is correct and this is the way it is wired into the circuit.

Horizontal Mounting

25X1A [REDACTED] assured us, and it was checked and found correct, that only a slight inaccuracy of the meter would result in horizontal versus vertical mounting of the thermocouples.

Replace 3 Ampere Meters with 5 Ampere Meters

The referenced memorandum is correct insofar as using 600 ohms where the resistance is concerned. However, under certain conditions, the impedance of the transmission line may be much higher OR lower. Considering a 50 ohm line terminated correctly, and $P = I^2 R$; 9×50 or 450 watts @ 3 amperes. Now if the resistance were lower, the indicated power would be less at the same current, but since the resistance is less, more current would flow, perhaps resulting in a burned out thermocouple at say, 40 ohms.

Through use, it was found that the 3 ampere meter used in the TAC-1 is a good value. When tuning the TAC-1 a current reading of one ampere is not uncommon and at times this meter is very helpful in tuning. Therefore, if a larger meter were used, say a 5 or 10 ampere meter, the indication on the larger meter may be too slight to be any help while tuning with these lower currents. Some of the values of the currents encountered are higher than 5 amperes; precluding the installation of a 5 ampere meter ~~are~~ ^{and} so far nothing over 10 amperes has been noted.

Use of a Black Box

While the TAC-1 can handle impedance variations over 20 to 1, it would be far better to adjust the antenna or transmission line for a more correct match than to widen this impedance range of the TAC-1 or increase its capacity by a further L-C combination. In essence; what is outside the range of the TAC-1 should be brought more close, not increase the range of the TAC-1.

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More Operating Instructions

It is felt that the instruction manual for the TAC-1 is adequate. Section II of the manual explains the theory of antenna tuners and with a small amount of operating time, the operator should readily be able to adjust the TAC-1 with a minimum of time and in the correct fashion. Perhaps it would be sufficient to point out that the TAC-1, even with its variable coupling and the tapped load control, can be set up correctly on a very few settings, but with enough variation to provide a smooth response when going through resonance. An operator, with a minimum of time and the present instruction book, should have no difficulty tuning the TAC-1 with a decent load. When the load is highly reactive and outside the range of the TAC-1, no further instruction would be of help.

Shunt for Meter

It was found that when operating the TAC-1 and noting an above three ampere current reading, when the output load was transferred to a decent load (500 watt light bulb) the current was not abnormally high. It may be that when the operator finds himself reading a current of three amperes with the transmitter on TUNE and not in a position to be able to construct a new antenna or correct the one used, a thermocouple shunt would be in order. For this shunt, unless remotely controlled, an extension of the RF leads to the thermocouple from a suitable switch would have to be made. A casual inspection of the compactness and general construction of the TAC-1 points up the fact that it may be difficult to insert a shunt even though this appears to be the most logical solution of operation with a high current.

Conclusion

The TAC-1 a well designed equipment meeting the specifications outlined in the instruction book. Operating complexity seems to be at a minimum for this type of equipment and no trouble should be experienced by the operators to cause them to burn out the thermocouples or meters by improper use. The meters and thermocouples are of high quality, accurate and are correctly wired in the circuit. A higher capacity meter would have to be in the order to 10 amperes and this would preclude the use of same when tuning with the low currents of one ampere or so. Good engineering practice would dictate

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the use of a better matched antenna and transmission line when abnormal currents are present. Further, when experiencing these abnormal currents, it should be pointed out that such a mismatch to cause this trouble indicated a very inefficient antenna and transmission line system. However, when the antenna or transmission line cannot be changed a thermocouple shunt seems to be the only solution.

Phase B of the project will be to undertake a study of the mechanical construction of the TAC-1 with the idea of incorporating a shunt. If this proves feasible, a modification work order will be made.

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